

Assessment of Sandcrete Blocks Manufacturers 'Compliance to Minimum Standard Requirements by Standard Organisation of Nigeria in Southwest, Nigeria

*Adekunle M. Ajao¹, Babatunde F. Ogunbayo¹, Kunle E. Ogundipe¹, Gideon O. Bamigboye²,
Ayodeji O. Ogunde¹ and Patience F. Tunji-Olayeni¹

¹Department of Building Technology, Covenant University Ota, Ogun State, Nigeria.

²Department of Civil Engineering, Covenant University Ota, Ogun State, Nigeria.

*Corresponding author

Abstract

Intensive use of sandcrete hollow blocks in building production has made it essential building materials in Construction Industries. This necessary need has made Sandcrete hollow blocks 'Manufacturers to play pranks in the Minimum Standard Requirement. This paper assesses the compliance level of Sandcrete Block Manufacturers to Minimum Standard Requirement in Southwest, Nigeria. 54 sandcrete blocks comprising 225 mm and 150 mm were gotten from blocks production sites within three states; Oyo, Ondo, and Lagos State. Samples of their fine aggregates were gotten for proper examination. In order to compare the outcome of the test results with standards, 18 numbers of controlled experimental units which comprised 225 mm and 150 mm were also produced. The results for sieve analysis of the three Samples gotten from South West along with Laboratory sample satisfied the requirement for BS 882:1992[1]. The results of compressive strength values gotten from blocks suppliers within South West failed to meet up the requirements stipulated for load bearing sandcrete blocks by Nigerian Industrial Standard (NIS 87: 2000)[2]. And also indicated shoddy control practice because strength results justified low standards and due to non-adherence to stipulated mix-design (1;8) of (cement and sand).

Keywords: Bulk density, Compressive Strength, Nigeria, Sandcrete blocks, Southwest

INTRODUCTION

Sandcrete blocks are composite materials produced from cement, sand and water, moulded into different sizes (Barry, 1999). British Standard (BS6073: 1981 Part 1) defines a block as a heterogeneous building material with a unit of larger size in all dimensions than specified for bricks but no dimension should be more than 650 mm nor should the height be greater than its length or six times its thickness. Sandcrete blocks are walling units which when laid in its normal aspect surpasses the dimensions stipulated for bricks (NIS 87; 2007). Baiden and Tuuli, (2004) opined sandcrete hollow blocks were used to construct over 90% of building structures in Nigeria. Therefore, sandcrete blocks remained essential component in housing production. Sandcrete block is generally used in Nigeria, Togo, and other developing countries as walling units which may be walls, partitioning walls and foundations. (NIS 87:2000) came out with the best plan to control production

process and assessment of quality materials in block production and reference document contained minimum requirements and uses of different kinds of sandcrete blocks was issued by the Standard Organization of Nigeria. Ogunbayo *et al.*, (2018) maintained that good housing projects need a standard designed, good planning, and good building materials that would be managed and controlled by government bye laws and construction professionals.

Sandcrete block tends to have high compressive strength when hardened and this strength usually improves with density. The range of specified minimum requirement of strength in NIS 87:2007 is 2.5 N/mm² for 150 mm while 3.45 N/mm² for 225 mm sandcrete hollow blocks. According to Abdullahi (2005) is of opinion that the kinds of production processes used and the qualities of composition of materials resulted to inconsistency in the blocks production quality. The study further stressed that of the compressive strength of sandcrete blocks produced in some parts of Minna, Niger State, Nigeria were below the minimum Nigerian Industrial Standard (NIS) requirement. And this was as a result of shoddy practices with stipulated mix design. Uzoamaka (1977) discovered that the compressive strength of sandcrete blocks tend to improve with low voids in sand properties and ensure curing by water sprinkling type. Rahman (1987); Oyetola and Abdullahi (2006); Oyekan and Kamiyo (2011) observed in their study the possibility of employing up to 40% rice husk ash (RHA) as a partial replacement of cement in sandcrete blocks production with no any prominent difference in compressive strength between 28 days and 60days.

(Afolayan, Arum and Daramola (2008) opined that quality management practiced has direct effect on the strength of sandcrete blocks. (Abdullahi 2005) is of opinion that best procurement of materials and proper curing process enhance good quality of sandcrete blocks. One of the greatest challenges being faced by the construction industry today is the incessant building collapse and nonchalant attitude towards materials testing to ascertain strength and behaviour of building materials under applied loads. Sholanke, Fagbenle, Aderonmu, and Ajagbe (2015) maintained that the use of poor quality of building materials such as blocks and bricks is responsible for the collapse of buildings. It is therefore highly essential to ensure that the production of sandcrete block and bricks is standardized and regulated in ensuring good quality. The outcome of Ede, Bamigboye, Olofinnade, and Shittu (2016) ascribed that cement trademarks and grains distribution

affect the compressive strength of normal concrete. In the same vein, Joshua, Olusola, Ogunde, Amusan, Ede, and Tunji-olayeni, (2017) maintained that factors such as knowledge on application of cement are responsible for low standard of concrete production in Lagos State, Nigeria despite the fact that cement are newly purchased and met the required standard.

Approved types and sizes for sandcrete blocks specified by NIS are shown in the Table 1.

Table 1: Types and sizes of Sandcrete blocks and their uses

Types	Work size (mm) L x T x H	Web Thickness	Use
Solid blocks	100 x 225 x 450	-	Non load bearing and portion walls
Hollow blocks	113 x 225 x 450	25	Non load bearing and portion walls
Hollow blocks	150 x 225 x 450	37-50	load bearing walls
Hollow blocks	225 x 225 x 450	50	load bearing walls

Source: NIS 587:2007

Okland (1991) opined that monitoring and compliance with standards are major ingredients to promote the achievement of quality control implementation. Despite the fact that the standards are laid down for both use and production of sandcrete block in Nigeria, the problem of quality control has still become order of day among many sandcrete blocks manufacturers within the country. The standards mostly employed are outdated and they are being used to meet local conditions.

In Nigeria, most sandcrete blocks' manufacturers employ the use of aggregates for production without minding its source, grain size distribution, and quality. Okland (1991) observed in his study that the quality of production process involved has a significant impact on the quality of the product and therefore the practice results to building failure before its required life span. The motivation for this study is to ensure conformity with minimum standard requirement and also the uniformity in the block production process by all manufacturers. This study therefore aimed at assessing sandcrete block manufacturers' compliance to minimum standards requirements by standard organisation of Nigeria in southwest, to examine the minimum standard requirements of

fine aggregates and sandcrete blocks being used, and to compare the quality of sandcrete blocks along with minimum requirements.

METHODS AND MATERIALS

This study used fine aggregates and 54 sandcrete blocks comprising 225 mm and 150 mm which were gotten from blocks production sites within three states; Oyo, Ondo, and Lagos State. These three States were chosen to avoid similarity of result from other states. And Samples collected from these States were also tested. To give basis for the comparism of test results with standards, 18 numbers of controlled experimental units which comprised 225 mm and 150 mm were also produced in Building Technology Laboratory, Covenant University, Ota, Nigeria and the following tests; Sieve analysis, Bulk Density, Organic content, and compressive strength were conducted where appropriate.

To establish the fact on block manufacturers' compliance level with specified minimum standards requirement, the analysis of the results from samples of sandcrete blocks gotten from the manufacturers and controlled sandcrete blocks of mix design (1:8,) cement : sand, was produced under the same atmospheric condition and employing the same production process as the manufacturers were then compared with minimum standards requirement and the discrepancies and short cuts from the manufacturers were observed.

COMPOSITION OF SANDCRETE BLOCKS

Sandcrete blocks' composite materials were fine aggregates, cement and water. These materials were discussed below:

Fine Aggregates: fine aggregates (sand) used for sandcrete blocks in this study complied with BS 882 (1996). The sand used for the study was clean and free from all organic matters. Grain size distribution, silt content and density test were conducted on samples to further establish the suitability of the sand before using the sand for sandcrete blocks (Gage 1971).

Cement: Ordinary Portland cement (OPC) grade 42.5R produced by Dangote was used and it was delivered in good condition.

Water: Portable water flowing within Department of Building Technology Laboratory, Covenant University, Ota, Ogun State was used for the study. It conforms to stipulated standard (BS 3148: 1980)

Mix-Design: 1: 8 (sand and cement) mix-design was used for the production of sandcrete block and this was batched by volume.

RESULT AND DISCUSSION

Table 2: Density for Manufacturers within South West

Manufacturers (S)	Dry Weight (kg)		Bulk Density kg/m ³		Mean Bulk Density kg/m ³	
	225mm	150mm	225mm	150mm	225mm	150mm
Lagos						
SA						
1	21.7	16.7	2136.4	2109.2	2065	2049.2
2	20.1	15.8	1978.9	1995.5		
3	20.9	16.0	2057.6	2020.8		
SB						
1	21.2	16.4	2087.1	2071.3	2044.5	2054.5
2	20.5	15.9	2018.2	2008.2		
3	20.6	16.5	2028.1	2084.0		
SC						
1	20.8	16.2	2047.8	2046.1	2110.1	2008.2
2	21.5	15.7	2116.7	1982.9		
3	22.0	15.8	2165.9	1995.5		
Ondo						
SD						
1	20.8	15.6	2047.5	1969.7	1983.5	1941.3
2	19.8	15.4	1949.1	1944.4		
3	20.6	15.5	2027.8	1957.0		
SE						
1	19.4	15.0	1909.7	1893.9	1962.2	1961.3
2	19.8	15.6	1949.1	1969.7		
3	20.6	16.0	2027.8	2020.2		
SF						
1	20.1	15.4	1978.6	1944.4	1929.4	1898.1
2	18.8	14.5	1850.6	1830.8		
3	19.9	15.2	1958.9	1919.2		
Oyo						
SG						
1	20.9	15.7	2057.4	1982.8	2023.0	1992.3
2	21.1	16.9	2077.1	2134.3		
3	20.3	15.4	1998.3	1944.9		
SH						
1	19.9	16.1	1959.0	1907.0	1972.1	1940.7
2	20.4	15.8	2008.2	1995.4		
3	19.8	15.2	1949.1	1919.6		
SI						
1	20.8	15.5	2047.6	1957.5	1975.4	1970.1
2	19.6	15.9	1929.4	2008.0		
3	19.8	15.4	1949.1	1944.9		
Pilot Lab Test						
1	23.1	18.2	2275.4	2292.2	2228.4	2167.6
2	22.9	17.5	2255.7	2204.0		
3	23.0	17.7	2265.6	2229.2		
4	22.8	16.9	2245.9	2128.5		
5	22.9	16.8	2255.7	2115.9		
6	22.0	17.7	2167.1	2229.2		
7	22.7	16.2	2236.0	2040.3		
8	22.2	17.5	2186.7	2204.0		
9	22.0	16.4	2167.1	2065.4		

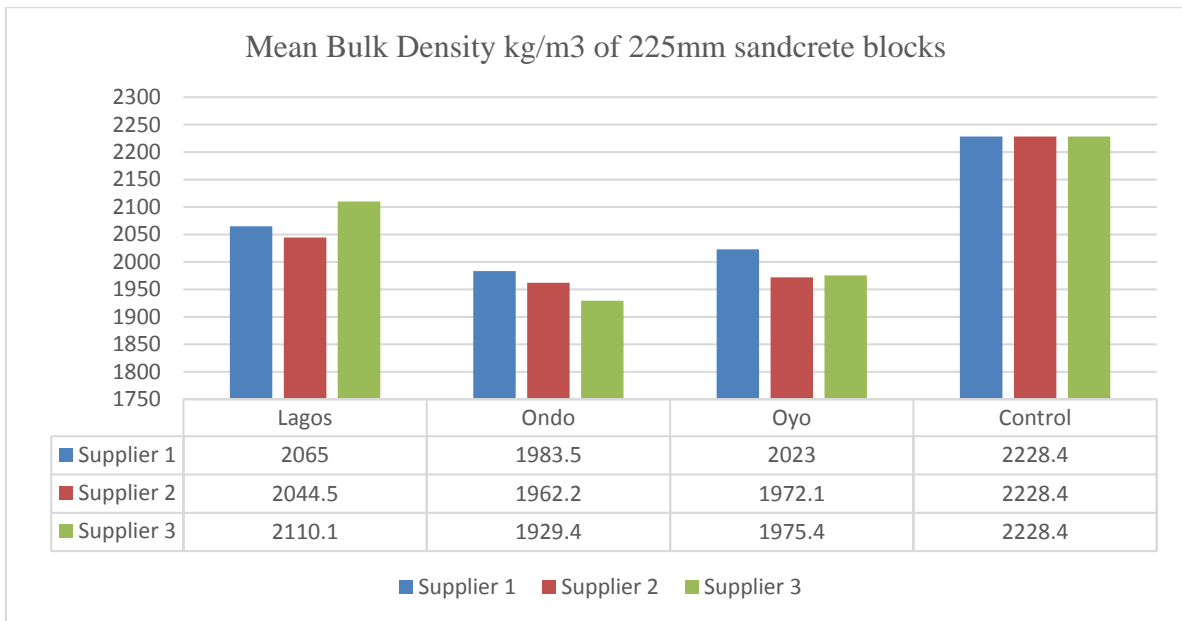


Figure 1: Mean Bulk Density kg/m³ of 225mm sandcrete blocks

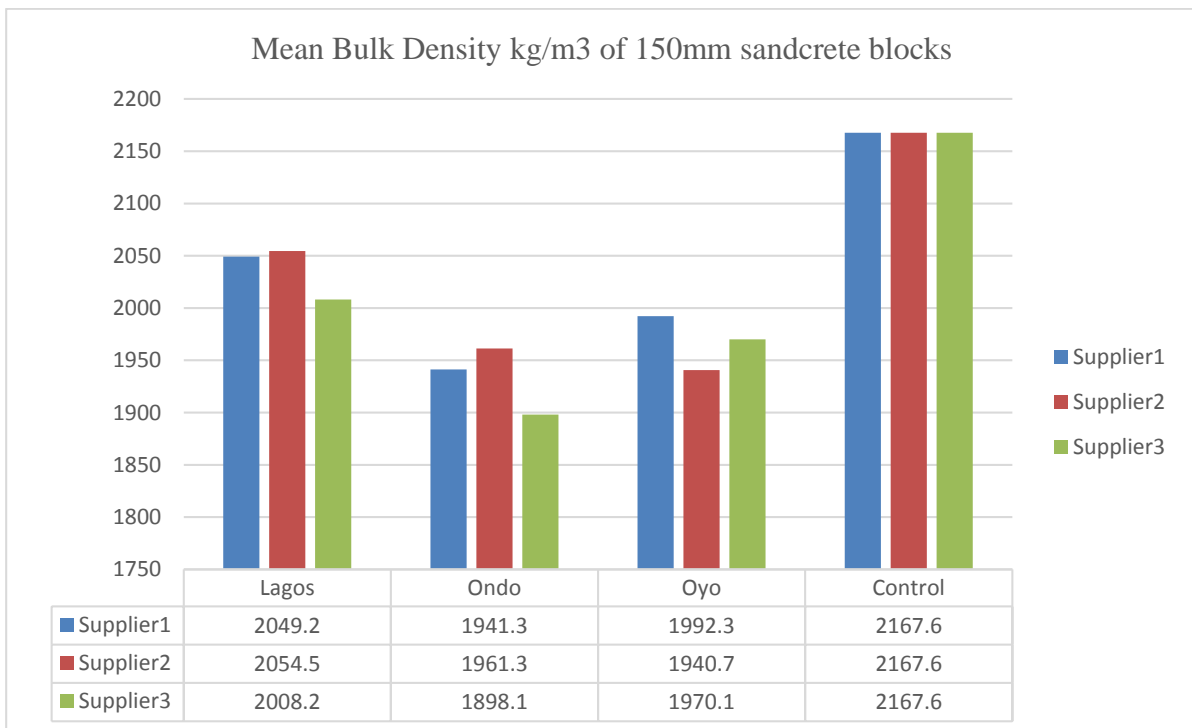


Figure 2: Mean Bulk Density kg/m³ of 150 mm sandcrete blocks

Density

Table 2 and figure 1 and 2 showed the densities of the sandcrete blocks from 9 manufacturers. The mean of the density of blocks from manufacturers were calculated. The mean of the densities of three (3) blocks was low with the value of 1929.4 kg/m³ from manufacturer SF (supplier from Ondo) and the highest value of 20654 kg/m³ from manufacturer SA (suppliers from Lagos) for 225x225x450 mm block while the average value of 150x225x450 mm with

lowest value of 1940.7 kg/m³ from manufacturer SH (suppliers from Oyo) and highest value of 2054.5 kg/m³ from manufacturer SB (suppliers from Lagos). But experimentally controlled units had the average value of 2228.4 kg/m³ and 2167.6 kg/m³ for both 225x225x450 mm and 150x225x450 mm. The results from above table which represented South West, Nigeria were found to fall within the stipulated value of 1920 kg/m³ for individual blocks and 2020 kg/m³ for an mean of three or more blocks.

Sieve Analysis Result

Table 3: Aggregate Sample from Oyo State

No of Sieve Sizes (mm)	Mass of Empty Sieve (g)	Mass of Sieve + Retained Aggr. (g)	Mass of Retained Aggr. (g)	% of retained Aggregate	% of Passing Aggregate
20.00	339	339	0	0	100
10.00	324	325	1	0.17	99.83
5.00	336	347	11	1.84	97.99
2.00	361	402	41	6.87	91.12
1.00	312	393	81	13.57	77.55
0.50	277	436	159	26.63	50.92
0.25	278	466	188	31.49	19.43
0.10	271	378	107	17.92	1.51
0.75	269	277	8	1.34	0.17
Pan	225	226	1	0.17	0
Total			597		

Source: Author's Laboratory Experiment 2017

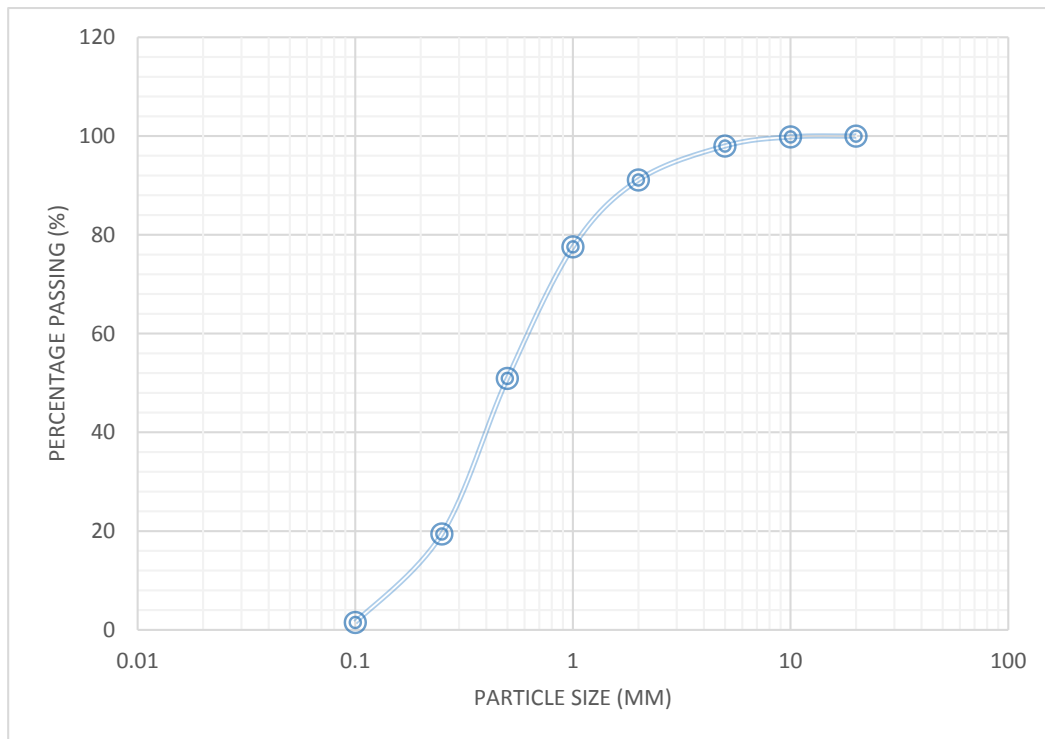


Figure 3: Particle size distribution for Oyo State

Table 4: Aggregate Sample from Ondo State

No of Sieve Sizes (mm)	Mass of Empty Sieve (g)	Mass of Sieve + Retained Agg.(g)	Mass of Retained Aggr. (g)	% of retained Aggregate	% of Passing Aggregate
20.00	339	339	0	0	100
10.00	324	325	1	0.17	99.83
5.00	336	347	11	1.84	97.99
2.00	361	402	41	6.87	91.12
1.00	312	393	81	13.57	77.55
0.50	277	436	159	26.63	50.92
0.25	278	466	188	31.49	19.43
0.10	271	378	107	17.92	1.51
0.75	269	277	8	1.34	0.17
Pan	225	226	1	0.17	0
Total			597		

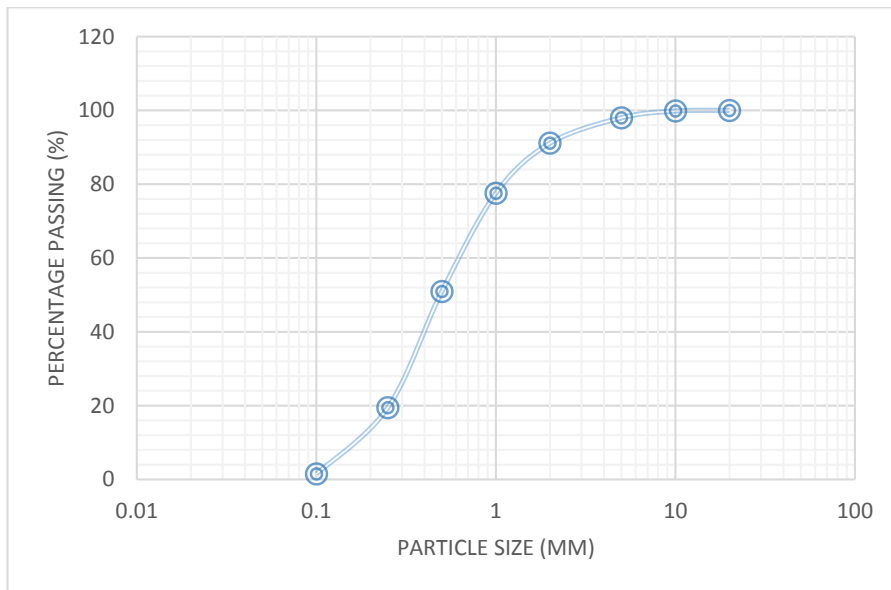


Figure 4: Particle size distribution for Ondo State

Table 5: Aggregate Sample from Lagos State

No of Sieve Sizes (mm)	Mass of Empty Sieve (g)	Mass of Sieve + Retained Agg.(g)	Mass of Retained Aggr.(g)	% of retained Aggregate	% of Passing Aggregate
20.00	344	344	0	0	100
10.00	324	326	2	0.4048	99.60
5.00	336	340	4	0.8097	98.78
2.00	362	418	56	11.33	87.45
1.00	314	478	161	33.19	54.25
0.50	282	450	168	34.00	20.24
0.25	282	366	84	17.00	3.24
0.10	272	268	16	3.24	0
0.75	268	277	0	0	0
Total			491		

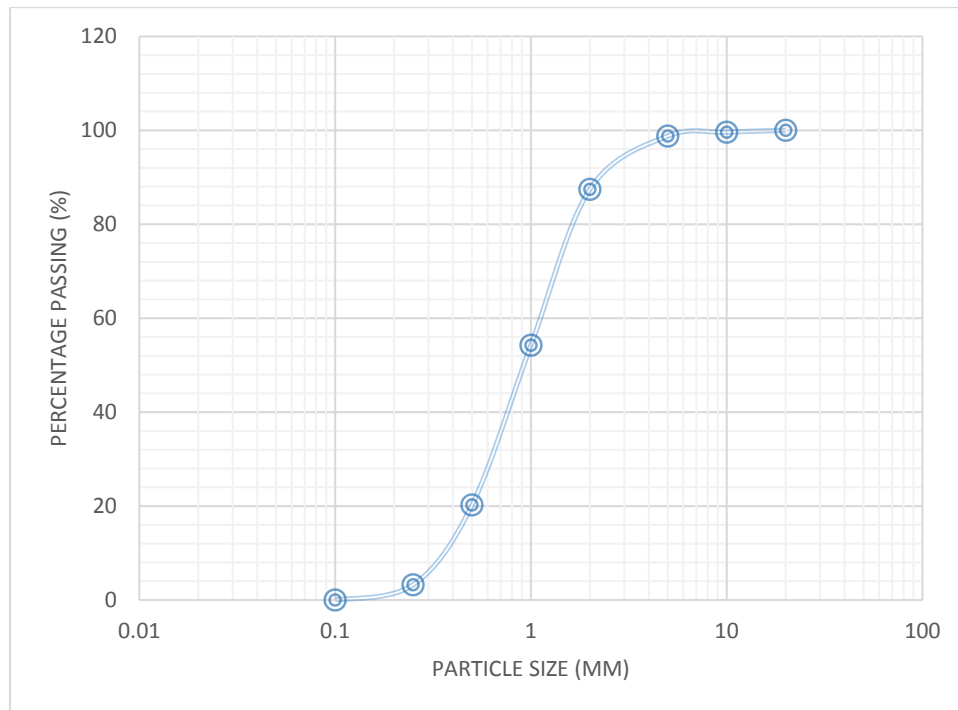


Figure 5: Particle size distribution for Lagos State

Table 6: Aggregate Sample from Lab. (Control)

No of Sieve Sizes (mm)	Mass of Empty Sieve (g)	Mass of Sieve + Retained Aggr. (g)	Mass of Retained Aggr. (g)	% of retained Aggregate	% of Passing Aggregate
20.00	344	342	2	0.513	99.487
10.00	174	174	0	0	99.487
5.00	338	358	20	5.128	94.359
2.00	368	508	140	35.897	58.462
1.00	154	206	52	13.333	45.129
0.50	282	328	46	11.795	33.334
0.25	278	466	60	15.385	17.949
0.10	271	378	66	16.923	1.026
0.75	269	277	4	1.026	0
Total			390		

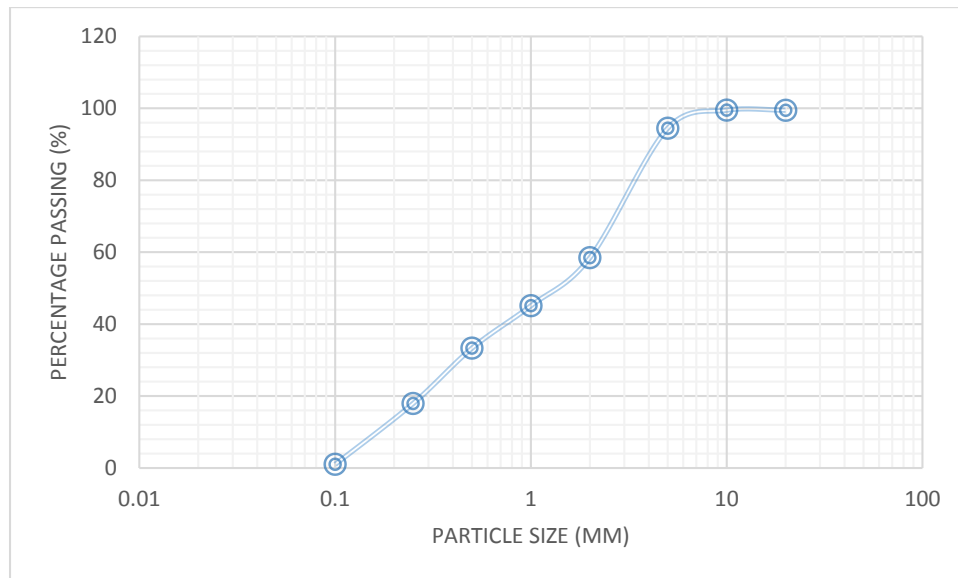


Figure 6: Particle size distribution for Laboratory (Control)

Particle Size Distribution

The results for the particle size distribution are shown in Table (3, 4, 5, and 6) as shown in Figure 3, 4, 5 and 6. The

three Samples gotten from South west along with Laboratory sample satisfied the particle size requirements of BS 882:1992[1].

Table 7: Compressive strength of sandcrete block

suppliers	Crushing Value 225mm (KN)			Crushing Value 150mm (KN)			Compressive Strength (N/mm ²)			Compressive Strength (N/mm ²)			Mean C.S 225	Mean C.S 150
	Y1	Y2	Y3	X1	X2	X3	Y1	Y2	Y3	X1	X2	X3	Y	X
LAGOS														
A	50	40	45	40	30	30	1.11	0.89	1.0	1.14	0.86	0.86	1.0	0.95
B	40	65	50	40	35	30	0.89	1.44	1.11	1.10	0.99	0.86	1.15	0.98
C	65	60	55	30	35	47	1.44	1.33	1.22	0.86	0.99	1.47	1.33	1.11
ONDO														
D	40	45	50	30	45	23	0.88	0.99	1.10	0.86	1.28	0.65	0.99	0.93
E	35	38	42	30	35	24	0.77	0.84	0.93	0.86	1.00	0.69	0.84	0.85
F	45	48	44	25	20	38	0.99	1.10	0.97	0.71	0.57	1.08	1.02	0.79
OYO														
G	60	45	48	45	20	25	1.33	0.99	1.10	1.29	0.57	0.71	1.14	0.86
H	46	50	40	30	28	27	1.02	1.11	0.88	0.86	0.80	0.77	1.00	.81
I	30	35	40	24	38	25	0.66	0.77	0.88	0.69	1.09	0.71	0.77	0.83
PILOT LAB. TEST														
J	150	160	180	130	120	90	3.30	3.50	3.96	3.65	3.37	2.53	3.59	3.18
K	190	200	170	110	100	120	4.20	4.40	3.75	3.10	2.81	3.37	4.12	3.09
L	200	160	185	90	110	95	4.40	3.50	4.07	2.53	3.10	2.67	3.99	2.77

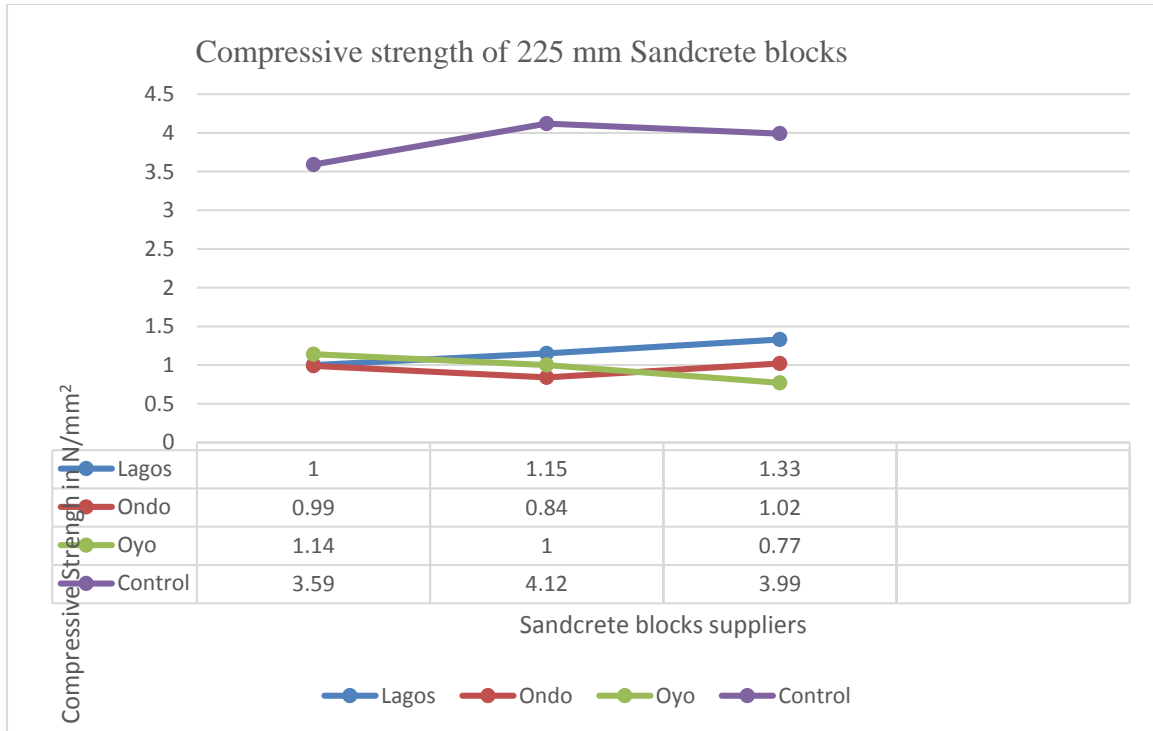


Figure 7: Compressive strength of 225 mm sandcrete blocks

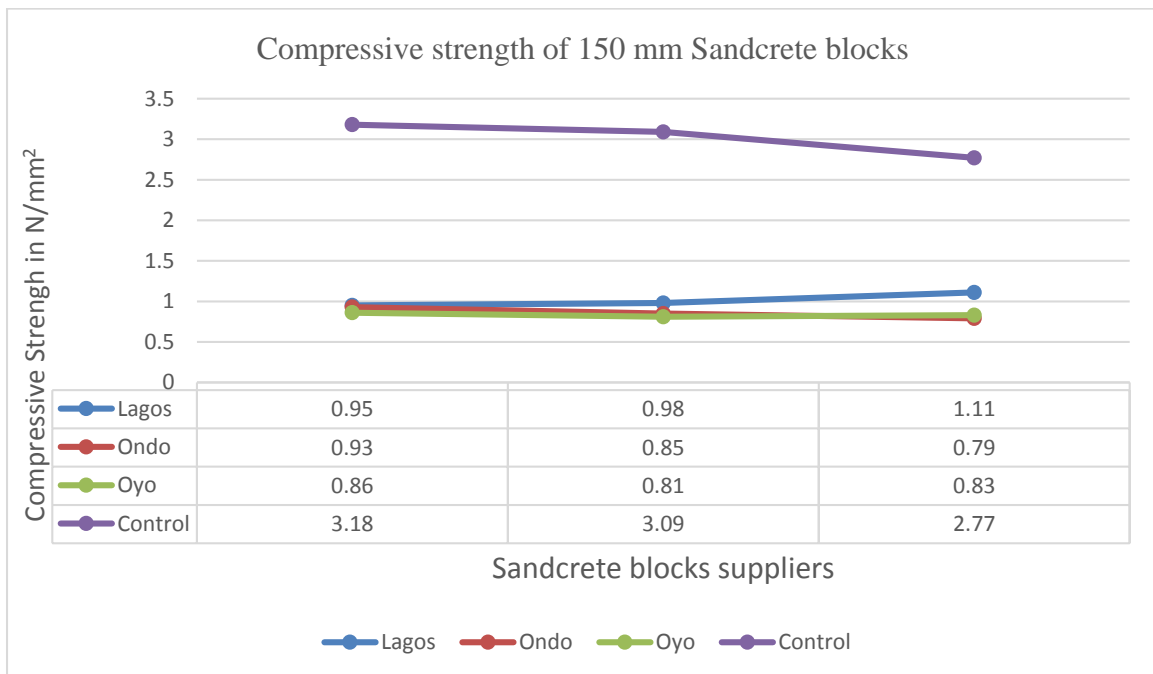


Figure 8: Compressive strength of 150 mm sandcrete blocks

Compressive Strength

The results for the compressive strength of sandcrete blocks are shown in Tables 7. Test results indicated that the compressive strength of sandcrete blocks manufacturers within three States; Lagos, Ondo, and Oyo ranged between 0.95 N/mm to 1.33 N/mm, 0.79 N/mm to 1.02 N/mm, and 0.77 N/mm to 1.14 N/mm. while the average compressive

strength of experimental controlled units ranged between 2.77 N/mm to 4.12 N/mm. These values gotten from blocks suppliers within South West were far behind the stipulated minimum standard for sandcrete blocks specified by Nigerian Industrial Standard (NIS 87: 2000) minimum of 2.5 N/mm² for individual block and 3.45 N/mm² for average of five blocks. The results also indicated improper quality

management practice observed among the manufacturers because the strength results were far behind stipulated standards. And also it indicated non-adherence to stipulated mix-design (1;8). The particle sizes results established the fact that the sharp sand used in the study area are suitable and well graded for construction purposes.

The entire block manufacturers within the study area used potable drinking water gotten from bore hole and as a result of this, it conforms to stipulated standard (BS 3148: 1980). It was also observed that curing process was not properly followed and also practised by manufacturers. The sandcrete blocks produced were not adequately cured to attain maximum strength. Most blocks were sold within three days of production without attaining maximum strength required. And this resulted to low compressive strength of the units which eventually have adverse effect on structural performance of the walling units.

CONCLUSION

The aggregates' grain size distribution of the sand used for the manufacturing of sandcrete blocks satisfied the requirement by BS 882: 1992[1] and therefore is recommended for block production. The results from table 2 which represented South West, Nigeria were found to fall within the stipulated requirement of 1920 kg/m³ for individual blocks and 2020 kg/m³ for the mean of three or more blocks.

In conclusion, the outcomes of compressive strength (0.77 N/mm and 1.33 N/mm) of the sandcrete blocks gotten from manufacturers were far behind the minimum standards required. while the average compressive strength of sandcrete blocks produced under similar condition in the Laboratory were between 2.77 N/mm and 4.12N/mm. and this controlled masonry units met the standards required. Therefore this study suggested compliance to already stipulated mix proportion of composite materials and improvement on curing process. And also regulatory bodies should be saddled with responsibility of enforcing the use of registered stamp on their sandcrete block to differentiate the low quality ones.

ACKNOWLEDGEMENT

We acknowledge Covenant University, Ota, Nigeria for creating research enabling environment.

REFERENCES

- [1] Abdullahi, M. (2005). Compressive strength of sandcrete blocks in Bosso and Shiroro areas of Minna, Nigeria. *AUJT*, 9(2), 126-131.
- [2] Afolayan, J. O., C. Arum, and C. M. Daramola. "Characterization of the compressive strength of sandcrete blocks in Ondo State, Nigeria." *Journal of Civil Engineering Research and Practice* 5.1 (2008): 15-28.
- [3] Baiden, B. K., & Tuuli, M. M. (2004). Impact of quality control practices in sandcrete blocks

- production. *Journal of Architectural Engineering*, 10(2), 53-60.
- [4] Barry, R. (1999). *The Construction of Buildings. (7th Edition)* Vol.1. pp 67-70. Blackwell Science, Oxford England.
- [5] British Standard 6073-Part 2: 1981 Precast Concrete Masonry Units. Method for Specifying Precast Masonry Units.
- [6] British Standards Institution. 1980. BS 3148: "Methods of Test for Water for Making concrete" British Standards Institution, London, England.
- [7] British Standards Institution. 1992. BS 882: Specification for aggregate from Natural Sources for Concrete: British Standards Institution, London, England.
- [8] British Standards Institution. 1996 BS 882; Specification for aggregates from natural sources for concrete: British Standards Institution, London.
- [9] Ede, A. N., Bamigboye, G. O., Olofinnade, O. M., & Shittu, K. K. (2016). Influence of Portland Cement Brands and Aggregates Sizes on the Compressive Strength of Normal Concrete. In *Materials Science Forum* (Vol. 866, pp. 78-82). Trans Tech Publications.
- [10] Gage, M. (1971). *Guide to concrete blockwork*, The Architectural Press, London
- [11] Joshua, O., Olusola, K., Ogunde, A. O., Amusan, L. M, Ede, Anthony N & Tunji-olayeni, P. F. (2017). Assessment of the Utilization of Different Strength Classes of Cement in Building Constructions in Lagos, Nigeria. *International Journal of Civil Engineering and Technology*, 8(9), pp. 1221-1233. <http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=9>
- [12] Nigeria Industrial Standard (2000), NIS87: 2000. "Standard for Sandcrete blocks". Standard Organization of Nigeria, Lagos.
- [13] NIS 87:2007. Nigerian Industrial Standard: Standard for Sandcrete Blocks. Standard Organization of Nigeria, Lagos, Nigeria.
- [14] Oakland, J. S. (1991). *Total quality management*, Butterworth-Heinemann, Oxford.
- [15] Ogunbayo, B. F., Ajao, A. M., Alagbe, O. T, Ogundipe, K. E., Tunji-Olayeni P. F. & Ogunde, A. O. (2018). Residents' Facilities Satisfaction in Housing Project Delivered By Public-Private-Partnership (PPP) In Ogun State, Nigeria. *International Journal of Civil Engineering and Technology*, 9(1), 2018, pp. 562-577. <http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=9&IType=1>
- [16] Ogundipe K. E., Ajao A. M., Ogunbayo B. F. & Amusan, L. M. (2015). Post Consolidation Effects of Banking Sector Recapitalization on Nigerian Construction Industry (Lagos and Ogun State Case Study); *Covenant Journal of Research in the Built Environment (CJRBE)* Vol.3, No.2. 68-80.
- [17] Oyekan, G. L., & Kamiyo, O. M. (2011). A study on the engineering properties of sandcrete blocks

produced with rice husk ash blended cement. *Journal of Engineering and Technology Research*, 3(3), 88-98.

- [18] Oyetola, E. B., & Abdullahi, M. (2006). The use of rice husk ash in low-cost sandcrete block production. *Leonardo Electronic Journal of Practices and Technologies*, 8(1), 58-70.
- [19] Rahman M. A. (1987). Properties of clay–sand–rice husk ash mixed bricks. *International Journal of Cement Composition Lightweight Concrete*; 9 (2):105–8
- [20] Sholanke, A. B., Fagbenle, O. I., Aderonmu, P. A., & Ajagbe, A. M. (2015). Sandcrete Block and Brick Production in Nigeria-Prospects and Challenges. *IARD International Journal of Environmental Research*, 1(4).
- [21] Uzoamaka, O. J. (1977). Some other factors which affects the crushing strength of Sandcrete Blocks. *Materials and Structures*, 10(1), 45-48.